stouter process ventrally, a flattened sclerite between cercus and clasper. Clasper trianguloid in lateral aspect, with dark, erect dorsomesal and broader dorsolateral points. Aedeagus produced into a long, slender apicoventral lip; thin lateral plates apically; internally with a pointed, tubular structure, and 3 small spines.

Material.—Holotype, male: Mexico, Edo. Veracruz, Arroyo Claro, Sierra Sta. Marta, Los Tuxtlas, 18 Dec 1976, J. Bueno S. USNM Type 76870.

Polycentropus alatus, new species

Figures 58–61

This species apparently is related to the preceeding two species on the basis of the presence of a small digitate lobe borne from the inner face of the cercus. However, the shape of ventromesal lobe of the cercus and the clasper is distinctive.

Adult.—Length of forewing, 5.5 mm. Color in alcohol brown. Fore and hindwings with R_2 present; hindwing lacking crossvein between R_3 and R_4. Male genitalia: Ninth segment with anterior and posterior margins slightly expanded ventrad. Tenth tergum membranous. Cercus, with dorsolateral lobe small, rounded apically, united to a long, declivious ventral lobe which ends in a short hook; dorsomesally with a lightly sclerotized area bearing a slender digitate lobe near midline. Clasper with a thin, erect lateral lobe ending in a spinelike process; mesal shelf unornamented. Aedeagus with a apicoventral lip produced into a slender process; thin lateral plates apically; internally with a single large spine and a complex of lightly sclerotized ill-defined structures.

Material.—Holotype, male: Mexico, Edo. Chiapas, Colon (Lagartero), (30 km. northeast of Ciudad Cuauhtemoc), 8 Apr 1979, J. Bueno. USNM Type 76871. Paratypes: Same data 7♂ 1♀ (USNM, UNAM).

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Nesting Behavior and Prey of Argogorytes *Ashmead (Hymenoptera: Sphecidae)*

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ABSTRACT

The nesting behavior and prey of 4 species of *Argogorytes,* a primitive gorytine genus in the sphecid subfamily Nyssoninae, are reviewed. The wasps nest in the ground and dig relatively shallow, multicellular nests, provisioning the cells with 3 to 30 homopterous prey. The Palaearctic *A. mystaceus* and *A. fargeii* prey on nymphs of the genus *Aphrophora* (Aphrophoridae). *A. carbonarius,* endemic to New Zealand, preys on nymphs of the genus *Carystoterpa* (Aphrophoridae). The European *A. hispanicus* preys on adults of the genus *Hysteropterum* (Issidae). The nesting behavior of *Argogorytes* is discussed and compared with that of related gorytine genera.

The genus *Argogorytes* was established by Ashmead (1899) for those gorytine wasps with a broad head, well developed epicnemium (prepectus), strong oblique groove on the mesopleuron, and other features. Bohart & Menke (1976) gave a full generic diagnosis and considered subgeneric divisions to be unjustified. *Argogorytes* is undoubtedly one of the most primitive gorytine genera and is nearly worldwide in distribution, being absent only from the Afrotropical (Ethiopian) region.

Nothing significant is known of the biology of the 2 North American or 4 Australian species, nor of most of the 18 other members of the genus. Both sexes of the Australian *A. rufomixtus* (Turner) have been reared from cocoons dug out of a sandy bank near Brisbane, Queensland, but the prey is unknown. However, some information on the nesting behavior and prey of 4 species of *Argogorytes* is now available. Three Palaearctic species have been studied in Europe and Japan, and meager observations made on 1 species in New Zealand.

The three European species are readily separable by keys given by Beaumont (1964), and Lomholdt (1976) re-described the 2 better known species that reach Scandinavia. Benno (1977) discussed these 2 species in the Netherlands with special reference to ecological preferences and the host associations of their cleptoparasites.

Argogorytes mystaceus mystaceus (Linnaeus)

Originally described in *Sphex,* the nominate subspecies is the best known and most widely distributed *Argogorytes,* ranging through the Palaearctic region. Bohart & Menke (1976) gave a full synonymy. It is a common wasp in Europe and occurs also in North Africa, but no recent observations have been found on its nesting habits. Shuckard (1837) was probably one of the first to note that it was common in Britain on Umbelliferae in June and July, and to report capturing it with prey, the nymph of *Aphrophora* sp., entering a sandbank.

Hamm & Richards (1930) referred to earlier work on its biology, recording nymphs of the spittlebug (froghopper) *Aphrophora spumaria* (Linnaeus) (Aphrophoridae) as prey, and *Nysson spinosus* (J. Forster) as a cleptoparasite. The female wasp was reported to fly to the nest carrying the prey by her mid-legs after extracting it from the spittle-mass. According to one account, the wasp inserted her legs and sting into the froth, and according to another she plunged her head in to effect capture of the prey.

Evans & Eberhard (1970) mentioned pseudocopulation of males with the flowers of the orchid *Ophrys insectifera* (Linnaeus) whereby the latter are pollinated. Lomholdt (1976) also referred to this and the classic experiments of Kullenberg (1961) in Sweden on the subject.

Argogorytes mystaceus grandis (Gussakovskij)

This subspecies was described from Ussuri district, Eastern Siberia, U.S.S.R. by Gussakovskij (1933) and occurs also in Japan and Korea. Tsuneki (1965) observed its nesting behavior near Lake Suganuma in the Nikko region of Honshu, Japan. The burrows of the nests were 8–12 cm in length and 4–4.5 mm across. In a unicellular nest the cell was at a vertical depth of 7 cm and in a bicellular nest cells were 2.5 and 3.7 cm deep, the cells lying horizontally and measuring 17 mm by 10 mm.

Tsuneki reported that the burrows were closed with sand in the absence of the wasp, and noted that the prey-laden wasp opened the closed entrance with the fore legs without relinquishing the prey. When the wasp entered the nest the prey was left in the entrance of the burrow, being visible from outside, and then disappeared down the burrow. Presumably the wasp turned around within the nest, because the prey was dragged down the burrow from inside. The wasp was observed to capture *Aphrophora* spp. (Aphrophoridae) carried venter to venter and head to head, but it was not explicitly stated whether the prey comprised nymphs or adults. A completed cell contained 4 prey placed in the cell head inwards and venter uppermost. The egg measured 2.8 mm by 1.0 mm and was laid on the prey lying innermost in the cell. It was attached by the caudal end to one of the hind coxae of the prey and the cephalic end reached the fore coxa.

Argogorytes fargeii (Shuckard)

This Palaearctic species is widespread but is less widely distributed than *A. mystaceus* and not as well known. Shuckard (1837), who described it in *Gorytes,* noted

that it was not uncommon in July on Umbelliferae in the London area and stated that he captured a female carrying the nymph of *Aphrophora spumaria* (Aphrophoridae). No recent observations seem to have been published on its nesting behavior.

Hamm & Richards (1930) summarized the observations of Adlerz (1906) in southern Sweden, who reported that the prey of this species (as *campestris* Mueller) comprised spittlebug nymphs of the genus *Aphrophora.* Adlerz stated that the wasp plunged legs and sting into the spittlemass to remove the prey, which was carried in flight by the midlegs to the nest. Burrows penetrated 10 cm vertically and the same distance horizontally into bare slopes of clay or gravel and were always left open. Nests were multicellular with 6–9 cells. In one nest 19–27 prey were found in each cell, but in a unicellular nest the cell contained 30 prey. In all cells the prey lay with heads pointing inwards, but neither egg nor larva was found.

Malyshev (1968) made some interesting comments on the absence of the egg in this and other instances, suggesting that it might be insecurely attached to the prey and fall off or be destroyed by the larva of an inquiline miltogrammine fly.

Nysson spinosus (see under *A. mystaceus*) has been recorded as a cleptoparasite of *A. fargeii,* but Benno (1977) has shown in the Netherlands that *N. spinosus* is restricted to *A. mystaceus* and *N. interruptus* Fabricius is a cleptoparasite of *A. fargeii.*

Argogorytes hispanicus (Mercet)

This species is known only from southern and central Europe. It was described in *Gorytes* from near Madrid by Mercet (1906) and has since been found in various other parts of Spain. Beaumont (1945) first recorded *A. hispanicus* from Switzerland, where it occurs in the Alps up to 1,800 m, and it has apparently been found in southern France. It is a little known species, and Beaumont suggested that it has probably been confused with its congeners and may range more widely.

The nesting behavior and prey of *A. hispanicus* were unknown until Janvier (1974)[1] studied a colony nesting at Málaga in southern Spain. Janvier reported colonies containing several tens of individuals, described digging, provisioning and nest structure, oviposition, structural features of the larva and its development, and cocoon formation. A nest with 6 cells and the mature larva with relevant structures were figured. The nest had burrows 10–20 cm long, and were multicellular with 5–7 cells, 15 mm long and 8–9 mm wide. The incubation period of the egg was said to be 4–5 days and the larval feeding period took a week. The ovoid cocoon was 11–12 mm long and 5 mm wide.

Janvier found that on hot days female wasps were active from 9000 to 2000 hours, alternating nesting activities with visits to the flowers of Umbelliferae to feed and with basking in the sun. No observations were made on males. Females explored vegetation for prey, which, when captured successfully, was taken to a nearby shrub and stung. In returning to the nest the wasp flew heavily with the prey held by the midlegs and landed a short distance from the entrance. Without releasing the prey, the wasp walked to the next, and, supported by the hind legs, used the fore legs to enlarge the entrance and took the prey down the burrow to the cell. The wasp returned repeatedly to the nest to deposit additional prey in the cell, the entrance being evidently left open during provisioning.

In excavating a nest, Janvier located a cell at the end of a burrow 14 cm long and within it found 8 paralyzed prey with the heads directed inwards. All the prey were *Hysteropterum reticulatum* (Herrich-Schaeffer). *Hysteropterum* is a widespread Holarctic genus with numerous species and belongs to the homopterous family Issidae. *H. reticulatum* is a well-known central and southern European species ranging from Germany to Sicily and Spain. One of the

[1] Janvier's paper was published in 1974 and is correctly cited by Bohart & Menke (1976), but appeared in *Graellsia,* 27, 1971 and this year is given in *Zoological Record, Insecta, Part E, Hymenoptera,* 110(13): 21.

first prey placed in the cell bore a minute larva. A second cell in the same nest contained 4 prey, the first one deposited having an egg attached to the upper mesopleuron. The egg was whitish, 2 mm long, somewhat curved, with the cephalic end directed towards the neck of the prey.

Janvier emphasized that the first prey placed in the cell was used for oviposition, stating that the wasp positions the prey on its side with the fore wings slightly apart to facilitate applying the egg lengthwise along the upper mesopleuron. After oviposition the wasp captures further prey, 6 to 10 journeys over several days being required to complete provisioning. The fully stored cell is closed with loose sand and an inner closure of the cell burrow made before the wasp digs the next cell. It was concluded that it required 4 or 5 weeks for a wasp to construct and provision the 5–7 cells in its nest with 40 to 50 adults of *H. reticulatum.* Wasps were said to spend the night in their burrows.

Argogorytes carbonarius (F. Smith)

This is the type species of the genus as designated by Ashmead (1899), and a series of the generotype was studied by Bohart & Menke (1976). *A carbonarius* is endemic to New Zealand and I recently discussed what is known of its biology (Callan, 1979). Gourlay (1930) was apparently the first to report this species (as *Gorytes*) preying on nymphs of the spittlebug *Carystoterpa fingens* (Walker) (Aphrophoridae). The prey was recorded as *Philaenus trimaculatus* White. Gourlay (1964) gave a brief account of the wasp provisioning its nest in the soil of garden beds at Nelson with late nymphal spittlebugs. Although he noted the source of the prey on young shoots of Meyer lemon trees, it was not stated how the nymphs were extracted from the frothy spittlemass surrounding them. The name of the prey was given by Gourlay in this paper as *Carystoterpa trimaculata* (Butler), which is a synonym of *C. fingens.*

The Aphrophoridae are represented by 2 species only in New Zealand and both belong to endemic genera. *C. fingens* was originally described in the genus *Ptyelus* and is a highly variable species. It is the more abundant and widely distributed of the 2 New Zealand aphrophorids and is found on various shrubs.

Gourlay did not record the length of the burrow of the wasp nor the number of cells constructed, mentioning only that up to 3 spittlebug nymphs were placed "in each burrow." Adult females of *C. fingens* vary in length from 7–9 mm, and the relatively large size of the late nymphs accounts no doubt for the small number of prey stored. Gourlay stated that on one of the prey "a single egg is deposited longitudinally between the rudimentary wings and the legs." He did not record whether the nest entrance was closed or left open in the absence of the wasp. In view of the fragmentary nature of these observations, it would be interesting to learn more of the nesting behavior of this New Zealand species.

Discussion

1. Species of *Argogorytes* nest in small colonies in the ground, usually in bare, flat, sandy soil, but also on slopes of clay or gravel, in sandbanks and in garden beds.

2. Adults of *A. mystaceus, A. fargeii* and *A. hispanicus* are reported to visit flowers of Umbelliferae.

3. Little is known of the behavior of male gorytine wasps, and no observations seem to have been made on the males of *Argogorytes,* except for those of *A. mystaceus,* which are remarkable in being attracted to and pollinating orchids.

4. Most Gorytini apparently spend the night on vegetation, but a few are thought to sleep in their burrows. Females of *A. hispanicus* are said to spend the night in their nests. Janvier (1928) reported that both sexes of *Clitemnestra* in Chile spend the night in the burrows.

5. *Argogorytes* females dig relatively shallow, multicellular nests with the fore legs, which have no tarsal comb or pecten. Burrows are reported to be 8–20 cm in length and 2.5–10 cm in vertical depth with

up to 9 cells measuring about 15–17 mm by 8–10 mm.

6. The nest entrance is closed in *A. mystaceus* but left open in *A. fargeii* in the absence of the female. In *A. hispanicus* the female on arrival with prey is said to enlarge the entrance, so it is presumably left at least partly open. Janvier (1974) used the verb "ensanchar" in his account of nesting in this species, and would surely have used "abrir" had the nest been closed. Most gorytine wasps close the nest entrance, but a few species, such as *Clitemnestra* in Chile (Janvier, 1928) and in Australia (Evans & Matthews, 1971), *Dienoplus* in Britain (Bristowe, 1948), and a species of *Hoplisoides* in Argentina (Evans & Matthews, 1973), are reported to leave it open.

7. In provisioning the nest, the prey is carried in flight by the female *Argogorytes,* using the legs to clasp it tightly venter to venter and head foremost. Several days are said to be required to complete mass provisioning a cell in *A. hispanicus* and the incubation period of the egg is 4–5 days, which is reminiscent of *Clitemnestra.* In *Argogorytes* the number of prey ranges from 3–30, placed in the cell with the head in and venter uppermost.

8. The prey in *A. mystaceus, A. fargeii* and *A. carbonarius* comprises nymphs of the family Aphrophoridae in the genera *Aphrophora* and *Carystoterpa.* In *A. hispanicus* the prey comprises adults of the family Issidae in the genus *Hysteropterum.* Both prey families are Homoptera Auchenorhyncha but pertain to different superfamilies—Aphrophoridae to Cercopoidea and Issidae to Fulgoroidea. *Argogorytes* was formerly thought to be exceptional in specializing on nymphal Aphrophoridae until the discovery of adult Issidae used as prey by the genus. Most gorytine wasps provision their nests with one or several homopterous families; *Ochleroptera* is reported to prey on 5 families and *Sagenista* preys on 6 families (Callan, 1977). By contrast, some *Hoplisoides* prey on numerous species of the single family Membracidae, and Evans & Matthews (1971) reported *Austrogorytes* in Australia preying on 7 species of one endemic family Eurymelidae. *Pseudoplisus* seems to be one of the few gorytine genera exhibiting a high degree of prey specificity, storing its nests exclusively with adult Aphrophoridae, one species of wasp restricting itself to a single species of prey. In South Africa numerous prey records from widely disparate areas indicate that *P. natalensis* (F. Smith) preys only on *Ptyelus grossus* (Fabricius), and *P. ranosahae* (Arnold) in Malagasy apparently preys only on *Ptyelus goudoti* (Bennett) (Callan, unpublished observations).

9. In most gorytine wasps, the egg is laid on the last prey deposited in the cell, being attached longitudinally on the ventral side of the thorax alongside the coxae (Evans, 1966). The egg is reported to be laid on the first prey placed in the cell in *A. mystaceus* and *A. hispanicus,* in the former species attached to the outside of one of the hind coxae and in the latter to the mesopleuron of the thorax. In *A. carbonarius* the egg is said to be laid between the wing-buds and the legs. In *Clitemnestra* in Chile the first prey is also reported to bear the egg, which is apparently attached to one of the midlegs (Janvier, 1928), and in *Dienoplus* in U.S.S.R. the egg is also evidently on the first prey deposited in the cell (Malyshev, 1968).

10. Cocoons in *Argogorytes,* as in related genera, are hard and ovoid, more pointed posteriorly, incorporating sand grains in the walls, but without mural pores. In *A. hispanicus* cocoons are reported to be 11 to 12 mm long and 5 mm wide.

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